SECRET

ROUTING AND RECORD SHEET

INSTRUCTIONS: Officer designations should be used in the "TO" column. Under each comment a line should be drawn across sheet and each comment numbered to correspond with the number in the "TO" column. Each officer should initial (check mark insufficient) before further routing. This Routing and Record Sheet should be returned to Registry.

FROM:	NO.
OC-E/R&D-EP	DATE 1 November 1956

TO	ROOM NO.	DATE REC'D	DATE FWD'D	OFFICER'S INITIALS	COMMENTS
1. R&D Lab					This project approved by R&D Ideas & Requirements Panel for lab. investigation on a time available basis. /// 11/1
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					CONFIDENTIAL
15.					

DOC 2 REV DATE 5-12-80 BY 808632
ORIG COMP ___ OPI ___ TYPE ___
ORIG CLASS S PAGES 6 REV CLASS C
JUST 22 NEXT REV 2010 AUTH: HR 70-2

FORM NO. 51-10
FEB 1950

16—61155-1 U. S. GOVERNMENT PRINTING OFFICE

SECRET

TASK OUTLINE
FOR
INVESTIGATION OF SECRET COMMUNICATION BY STANDARD LIGHT BULB

I. PROBLEM:

It is well-known that a light bulb connected to a sixty cycle line is actually varying in intensity 120 times per second even though these fluctuations are not noticeable. The problem is to investigate the possibility of a system of communication using these light fluctuations as a communications medium. The investigation should consider both voice and code transmission. Major emphasis should be placed on simplicity and smallness of both the transmitter and receiver.

II. WORK TO BE PERFORMED:

a) The initial investigations should determine how the percentage of amplitude modulation, frequency of modulation, light brightness and amount of background light affect the threshold noticeable flicker.

b) A second investigation should determine at what range the modulation can be detected by a sensistive photocell with the light modulated just below the threshold of flicker noticeability. The second investigation should be performed with 20-watt incandescent and fluorescent bulbs utilizing amplitude, frequency shift, phase shift, and wave-shaping type modulation.

c) Possible transmission and reception methods should be evaluated on the basis of the results of these two investigations.

d) Working models of the more promising systems should be built.

III. DISCUSSION:

1. An experiment has been performed in which the photocell of a small movie projector was illuminated by incandescent and fluorescent bulbs connected to a sixty cycle line. The output of the movie projector audio amplifier was displayed on an oscilloscope. The resulting wave shape was of such amplitude and sharpness that it would seem possible to transmit information by frequency shifting, phase shifting, or wave shaping of the normal sixty cycle fluctuations of light bulbs. Due to the nature of the experiment, it was not possible to determine the level of fluctuation of light amplitude.

2. Appendix A contains some suggestions on methods of generation and detection of keyed modulation. These suggestions should be among those evaluated on the basis of the two investigations.

3. At the General Electric "House of Magic" display, a device was exhibited which transmitted recorded music over a light beam. It has been reported that this device used amplitude modulation but that the modulation was not noticeable.

APPROVED:

[redacted] 25X1

Chief, Research & Development Branch, OC

PRIORITY:

Time Available Basis

APPENDIX A

1. The following code generation and reception methods should be among those evaluated:

a) Generation of frequency shift by keying a rectifier in and out of the lamp circuit (Figure 1). Resistor R is of such value that the light output does not vary when either the rectifier or resistor is in series with the lamp. The key should be designed to be similar to an electrical commutator (i.e. the moving contact always touches either the resistor or rectifier contact and the circuit is never open). Such a circuit will shift the light fluctuation frequency from 120 cycles to 60 cycles.

b) Generation of phase shift by making the key a part of the magnetic circuit of an inductance in series with the lamp as shown in Figure 2. The advantage of such a device would be that opening and closing contacts is avoided.

c) Generation of phase shift by saturation as in Figure 3. In this figure windings N-1 and N-3 are the windings of an auto transformer which has low mutual coupling due to the leakage path through the center leg and in which the winding N-3 bucks winding N-1. Winding N-2 is the control winding which is short circuited when the key is depressed and whose core has a smaller cross sectional area than the cores of N-1 and N-3. When the key is up and the control winding is open, the mutual coupling between N-1 and N-3 is low and the bucking voltage induced in N-3 is consequently low. Also N-3 has a large leakage inductance causing a phase shift in the light bulb current. When the key is down, short circuit current flows in the control winding saturating the center transformer leg, the leakage inductance of N-3 decreases reducing the phase shift and the mutual coupling with N-1 increases, increasing the bucking voltage induced in N-3. Thus the device has provided phase shift without change in output voltage.

d) Generation of wave shape keying by keying a neon bulb in parallel with the light bulb so that the peaks of the applied voltage are clipped.

e) Generation of phase shift keying by a movable transformer core. For example, the device shown in Figure 4 has two primaries, one of which is phase shifted with respect to the other through the phase shifting capacitor C. Rotating the movable core from one primary to the other will cause a shift in phase without any decrease in load voltage. The same effect could be obtained with a two phase wound rotor motor.

f) A receiving device for phase shift or frequency shift modulation in which a tuning fork resonant at twice the line frequency is illuminated by the transmitting light bulb. Such a device would be similar to a stroboscope and any change in phase or frequency of the transmitting light would cause the apparent position of the tuning fork to shift to another position or move continuously.

g) Receivers in which the optical path to the eye is blocked in synchronism with the unkeyed light, the phase shift or frequency shift allowing light to pass. Possible devices for synchronously blocking the optical path includes: reed resonant at 120 cycles and actuated by a throttled CO-2 cartridge, a tuning fork, and an electric or spring motor turning a slotted disc.

h) Receivers using photoelectric cells. In such receivers a second photocell directed toward a second unkeyed light operating from the sameAC line would provide a synchronized reference voltage.

i) Generation of non-symetrical keying by a full wave rectifier. with a movable center tap as in Figure 5.

SECRET

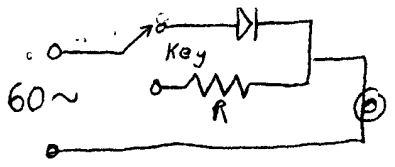


Fig 1

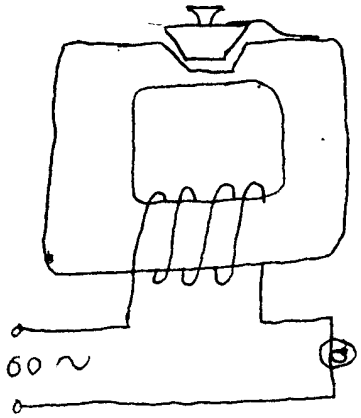


Fig 2

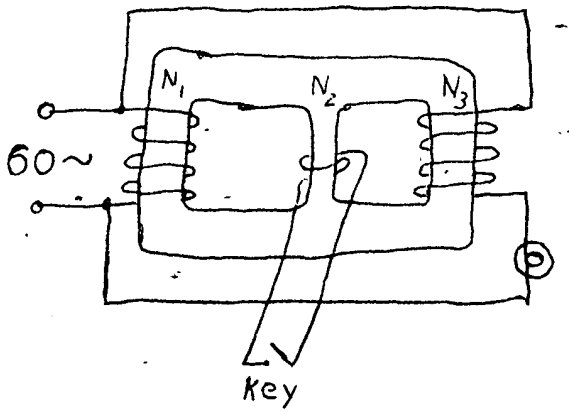
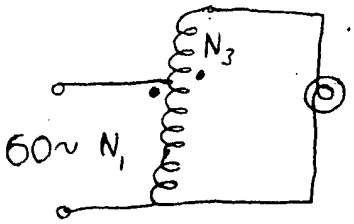


Fig 3



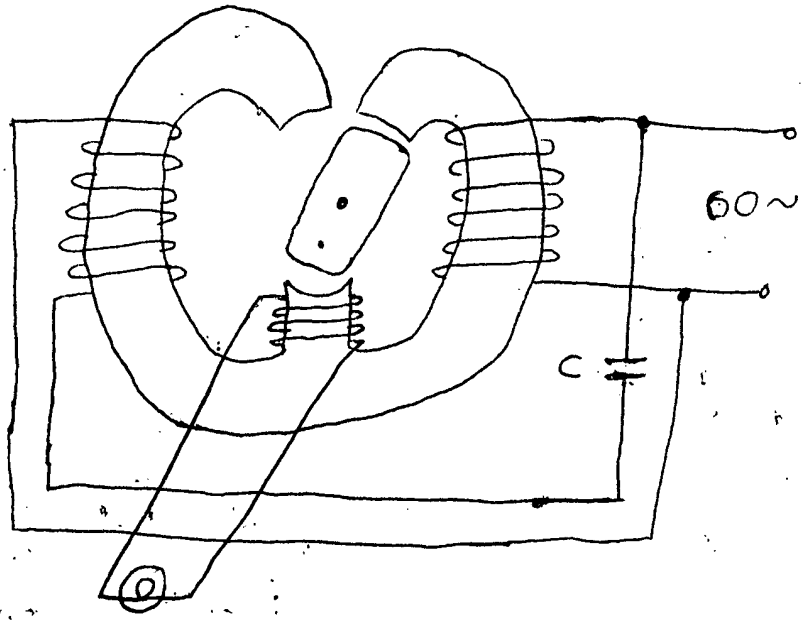


Fig 4

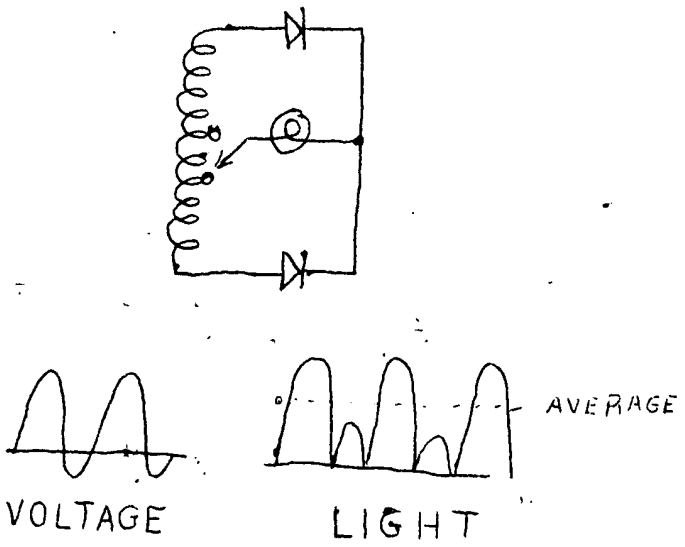


FIG 5

SECRET